Received: 16 May 2020 | Revised: 10 July 2020 | Accepted: 16 August 2020

DOI: 10.1002/pa.2441

ACADEMIC PAPER

WILEY

Environmental performance of Turkey amidst foreign direct investment and agriculture: A time series analysis

Edmund Ntom Udemba | **Anton Abdulbasah Kamil** | **Orhan Özaydın**

Department of International trade, Faculty of Economics Administrative and Social Sciences, Istanbul Gelisim University, Istanbul, Turkey

Correspondence
Edmund Ntom Udemba, Department of International trade, Faculty of Economics Administrative and Social Sciences, Istanbul Gelisim University, Istanbul, Turkey.
Email: eudemba@gelisim.edu.tr, edmund.ntom@alumni.emu.edu.tr, eddy.ntom@gmail.com

This research work is developed with interest on the performance of Turkish sustainable development amidst high inflow of foreign direct investment (FDI) and excessive usage of fossil fuels (crude oil and gas). Turkey has been identified as among the countries yet to ratify their agreements with both Kyoto and Paris agreements in fight to reduce the global warming. It is essential to investigate to know if Turkey is promoting climate change as could be among the reason why it fails to work in line the agreement to reduce the global warming. The authors adopted quantile regression (QR) to study the linear relationship that exist among the selected variables in order to have a valid conclusion on the stand of the Turkey towards the control of global warming. Our findings are: A negatively significant relationship between the carbon emission and the agriculture in the all the quantiles except the 90% quantile which shows a positive relationship. Also, the ordinary least square (OLS) estimate which acts as a robust check to the quantile findings confirms a negative relationship between the carbon emission and agriculture. A positively significant relationship is established between energy use and carbon emission in all the quantiles. EU (energy use) is statistically significant for the 30, 40, 50, 70, 80 and 90% quantiles. EU is more statistically significant for the 90% quantile than lower quantiles. Again, a mixed (both positive and negative) relationship is established between foreign direct investment and carbon emission in all the quantiles which shows that FDI is impacting the Turkish environment a mixed manner. It shows that the foreign investors still engage in both clean and dirty production in Turkey. This finding gives support to both pollution halo/haven hypothesis (PHH) in Turkey. However, a 1% point increase in GDP per capita increases the carbon emission both in the 10% quantiles and OLS by 2.82 and 2.797% respectively. This shows a positive relationship that exist between GDP per capita and the carbon emission. GDP is statistically significant for all quantiles, and show that there is a strong relationship between CO_2 and GDP. Turkish sustainable policies should focus on promotion of clean FDI and agricultural practice with economic growth anchored on renewable energy sources.

1 | INTRODUCTION

Foreign Direct Investment (FDI) is among the agents of the economic growth if managed and utilized well through the effective policies of the host countries. It has innumerable impacts on the economy of the host country which are classified into three: competitive effect, linkage effect and employment effect. These effects reflect on the production that transcends to positive Gross Development Product (GDP), host trade relationship with other countries, balance of payment, and the general welfare of the host country (Lee, 2013). The

competitive effect is seen when the efficiency of the domestic firms is impacted positively through the competitiveness of the foreign backed established firms. In order to remain in the production and market, there is a need for an upgrade in quality of goods and services provided by the local firms due to the presence of the foreign owned firms in the host country. This encourages innovation and research and development in the industry which pave way for economies of scale thereby benefiting both the producers and the consumers in the host countries. The linkage effect will set in the process of innovation and research and development by the local firms. The local firm will enjoy the technical support from the foreign owned companies which will definitely impact on their production techniques. The employment effect is sometime called spillover effect which allows the transference of the experienced workers and experts from the foreign owned companies to the local companies via employment and this equally benefits the local companies through skills and knowledge transfer (Gorg & Stroble, 2001). FDI has proven to be a significant agent of globalization that contributes in building strong economic ties between the economic blocs. Turkey is not left out of the benefits of FDI starting from the 1980's after its economic reforms that are anchored on; free market economy, relaxation of state intervention and integration of its economy with the world economic system. Factors such as market size, proximity to market, raw materials and labour supply have been instrumental in attracting foreign investors into Turkey.

Agricultural activities have equally proved among the inducers of some emerging countries economic growth, such as Turkey (Udemba, 2020a). Agricultural activities play vital role in an economy both as a means of sustenance and economic growth. Farming is a sources of sustenance through food production ether in subsistence mode or mechanized mode. Apart from the sustenance via food production, farming is a source of export to some of the developing economies. Turkish agricultural policy is mainly targeted towards the efficient provision of food supply to support the domestic food market and to lower the domestic cost of food domestically. Though, the export of its agricultural products to other regions such as Middle East and North Africa is continuously increasing.

As Important and beneficial as the two sectors are to the Turkish economic performance and development, there are some sustainability concerns with regards to environmental quality attached to their operations. It is generally believed that the practices involve in agriculture can sometimes constitute ecological threat such as land recovering, utilization of machineries that run on fossil fuels such as fuels and gases, utilization of chemicals like fertilizers to boost their production (Udemba, 2020b) for India. The machines that use fossil fuels are capable of emitting carbon emissions into the environment, so also, the chemicals applied to the farming could be washed off by the running water and transferred to water bodies which can also be harmful to the aquatic life (Udemba, 2020b) for India. The land recovery is also ecological threat because, it will lead to damaging of forest life which affect both the trees and the animal species and equally increase the impact of unutilized carbon dioxide by plant (Pandey et al., 2012). Moreover, the activities of foreign investors especially on the economies of developing countries can negatively affect the environment of the host country if not checkmate with regulatory policies (Shahbaz, Dube, Ozturk, & Jalil, 2015). Apart from the above mentioned factors that determines FDI, most times, the foreign investors prefer to locate their businesses and productions in the developing countries because there is less strictness in their mode of operation than the developed economies who are known with high regulatory policies in production activities. Foreign investors from the industrialized nations who still practice dirty production with high energy consumption and emission technologies seek to transfer and locate their production activities to the developing countries with lesser regulatory laws. They utilize the opportunity to engage on production that constitute pollution to the environment. Sometimes, there may be little or no tax to curtail their excesses towards the environmental degradation.

The energy use in Turkey is rated high because of its industrial engagement, and its emission is forecasted to triple from 430Mt CO_2e in 2012 to 1175Mt CO_2E IN 2030 (Carbon Brief, 2018). Turkey has remained the Only G20 and among the largest emitters that refused ratify its signed Paris pledge and with no commitment towards emission reductions after joining Kyoto Protocol in 2009 (Carbon Brief, 2018). Turkey's commitment to emission reduction was rated insufficient. Its commitment fails in both the fair approach of keeping warming below 2°C and the limiting of the emission to 1.5°C. Turkey is equally identified as among the countries that are obsessed with reduction in the energy import while shifting its policies towards domestic generation of its energy. The current policy with a target of 2023 is considering expansion of coal generation power and floating of storage and regasification units. These policies are considered capable of overshooting the Paris Agreement of long term temperature goal if fully floated for operation.

Following the partial involvement of Turkey in curtailing the climate change and its recent policies towards expanding its fossil fuel (Coal) energy source to reduce the over dependence in oil and gas importation, the authors have considered it timely to research on Turkish environmental performance. Considering, how important FDI and agricultural production are to the Turkish economy and the likely emission to generate from these sectors, the authors also consider it important to test the environmental performance with these indexes (FDI and agricultural). The findings from this research will be relevance to other emerging countries that have adopted the growth path through FDI and agriculture. The findings will equally assist in policy framing by the authorities of Turkey to cushion the likely negative effects of FDI and agriculture in pursuit of sustainable development of the country. The present work is uniquely different from the existing works which always measure the environmental performance of Turkey with only FDI. The current adopt both FDI and agriculture to measure environmental quality of Turkey. Also, in a bid to find something different from the general techniques, the authors applied bound testing and quantile regression (QR) estimation for a clear and robust finding. The reason is, in the linear regression only summarize the mean of relationship between the explanatory variable and the response variable based on E(y|x), where explain the relationship in

general. Here, we are interested to see the relationship at specific points, the suitable analysis is QR. QR is more robust compare with linear regression if the errors are extraordinarily non-normal and if there is exist an outliers.

The rest section of this research will be as follows: Section 2: Theoretical Background & empirical reviews, Section 3: Data and methodology, Section 4: Empirical results and discussion, Section 5: Conclusion and policy recommendation.

2 | LITERATURE REVIEWS

Patterns in the level of economic activity (GDP), energy consumption, foreign direct investment, agricultural economic activities and CO_2 emissions of a country have been investigated in the former literature using suitable indicators. Several studies have reported many interesting results. There are many studies in literature using different models and data consisting of economic and environmental variables. In this section, we provide information about past literature's econometric model, data and results. First of all, we list the literatures that consist of the Turkey's indicators, later recorded other literatures consisting other individual countries and some "specific" set of countries, such as ASEAN, African, BRICS, EU. Seker, Ertugrul, and Cetin (2015) focused on Turkey's data over the period from 1974 to 2010. The autoregressive distributed lag (ARDL) model were used in order to investigate short and long run co-integration relationship between CO_2 emissions and other FDI, EC, GDP variables. The vector ECM based Granger causality test was also applied to understand the causal relationships. The long-run coefficients of the ARDL model represented that there was a positive effect of FDI on CO_2 emissions but relatively small, however, the effects of the GDP and energy consumption on CO_2 emissions were outstanding. The causality test results showed the presence of a causality running from all GPD, FDI, EC variables to CO_2 emissions in the long run. Ertugrul, Cetin, Seker, and Dogan (2016) also analysed same variables on in the top 10 CO_2 emitters among the developing countries; namely China, India, South Korea, Brazil, Mexico, Indonesia, South Africa, Turkey, Thailand and Malaysia over the period of 1971–2011. By helping of ARDL model bound testing for cointegration and The vector error correction model (VECM) Granger causality method, they stated one-way long run causality running from EC and GDP to CO_2 emissions for Thailand, Turkey, India, Indonesia, China, Brazil and Korea. Moreover, GDP and EC were the main determinants of carbon emissions in the long run. Individually the perspective of Turkey, when increasing 1% energy consumption resulted 0.958 increase on CO_2, and respectively increasing 1% GDP raised CO_2 emission by 4.470%. Lee (2013) analysed panel data of 19 nations of the G20 including Turkey from 1971 to 2009 to find out long-run equilibrium relationship by employing of cointegration tests. The test results of the research represented that FDI was an important factor for GPD for the G20, however it impacted on an increase in CO_2 emissions but limited. Beside, GDP and EC had positive correlation with CO_2 emissions in the G20 economies.

In past studies represented that there were positive causality effects running from GDP, FDI or EC to CO_2 over selected Asian Countries. Liu, Zhang, and Bae (2017) employed the Granger causality and VECM to understand relationships between per CO_2 emissions, real GDP, renewable and non-renewable energy, and agricultural value by using a panel of Association of Southeast Asian Nations (ASEAN-4: Indonesia, Malaysia, the Philippines, and Thailand) from 1970 to 2013. Long-run bidirectional Granger causalities were provided between per capita CO_2 emissions, renewable and non-renewable energy. Short-run tests concluded that there were one-way causalities from agriculture and real GDP to emissions and from non-renewable energy to CO_2 emissions. Behera and Dash (2017) examined the relationship between EC, FDI and CO_2 of 17 countries in the South and Southeast Asian (SSEA) region over the period 1980–2012. In order to discover the volume of CO_2 emission in 17 countries, Pedroni cointegration results revealed that primary energy consumption, and FDI considerably affected the CO_2 emission in the SSEA region. Lau, Choong, and Eng (2014) focused on Malaysia to identify the relationship between economic growth GPD, FDI and CO_2 emissions for the period from 1970 to 2008 for Malaysia. Their ARDL model suggested that there were long run relationships and positive interactions between these variables. To illustrate, increasing 1% GDP raise CO_2 by 9.661% and 1% FDI raise CO_2 by 0.069%. Zhang and Cheng (2009) researched the existence and direction of Granger causality between GDP, EC, and CO_2 emissions in China over the period 1960–2007. Long run empirical results showed that unidirectional Granger causalities existed from GDP to EC, and from EC to CO_2 emissions.

Coming to African aspect; Kohler (2013) studied long run relationship between EC and CO_2 during the period 1960–2009 in South Africa. As their granger causality tests suggested existence of a bidirectional relationship between EC and CO_2 emissions. In ARDL long run relationship model results represented that there was positive behaviour of CO_2 emissions with respect to EC, and it was stated that for each 1% increment in per capita EC, per capita CO_2 emissions increase by 1.17%. Another African country research was about Ghana which was worked by Asumadu-Sarkodie and Owusu (2016), showed the result of a causal relationship between CO_2 emissions and agriculture. Nine agricultural production and CO_2 variables range from 1961 to 2012 were retrieved from the Food Agricultural Organization. The VECM and the ARDL represented the confirmation of a causal relationship between CO_2 emissions and agriculture.

Studies comprised set of other countries also were conducted in former literature, such as consisting of BRICS countries, Europe, UK, and USA. Pao and Tsai (2010) investigated dynamic causal relationships between CO_2 emissions and EC for a panel of BRIC countries spanning the period from 1971 to 2005, excluding Russia (1990–2005). The panel causality results stated that bidirectional strong causality and energy consumption existed. By help of ARDL cointegration bounds test approach, Acaravci and Ozturk (2010) examined the causal relationship between EC, GDP, and CO_2 for 19 European countries. Their econometric model indicated that there was an existence of a long-run relationship between carbon CO_2, EC,

and GDP only for Denmark, Germany, Greece, Iceland, Italy, Portugal and Switzerland. Moreover, they stated the positive long-run elasticity estimate of CO_2 with respect to EC significantly for Denmark, Germany, Greece, Italy and Portugal. Cetintas and Sarikaya (2015) examined GPD, EC, and CO_2 data and compared between USA and UK over the period from 1960 to 2004. Employed cointegration test results confirmed the existence of a long-term relationship between these variables. While economic growth in the UK has a positive effect on CO_2 emissions in the short and long term, economic growth in the USA has no effect on CO_2 emissions. In both countries there was a positive relationship between energy consumption and CO_2 emissions. Unidirectional causality from CO_2 to economic growth in the UK and from energy consumption to CO_2 emissions in the USA existed respectively. In both countries, no causality relationship has been found between energy consumption and economic growth.

2.1 | Theoretical background

The theoretical background of this work is anchored on the Pollution Haven Hypothesis (PHH). This hypothesis is conceived with the idea that most of the foreign investors transfer their productive activities to the countries, especially the developing and emerging countries because of less stringent environmental laws. Most times, the laws could be in form of relaxation of tax which is a policy instrument to attract foreign investors into the economy for economic growth and development. FDI has some positive effects to the host country's economy which ranges from competitive effect, linkage and employment effects, and capital formation effects. These effect impact favourably to the economic growth of the host country. Asides, from the economic benefits of the FDI, inflow to the host economy, the FDI could affect the environmental quality of the host economy. The environmental impact may be either positive or negative. Where the impact is positive, it is said to be Pollution Halo Hypothesis (PHH), and where the impact is negative, it is said to be Pollution Haven Hypothesis (PHH). The FDI could be positive when its presence in the host country brings cleaner production through innovation and advanced technology which will reduce the emission rate in the country (Acharyya, 2009; Asgari, 2013; Sarkodie & Strezov, 2019; Shahbaz et al., 2015; Solarin, Al-Mulali, Musah, & Ozturk, 2017). But, where the foreign investors engage in dirty production with machines that utilize the high fossil fuel energy sources which are capable of polluting the environment, it is said to be negatively impacting the environment of the host country (Alfaro et al., 2010; Al-mulali & Tang, 2013; Bustos, 2007; Udemba, 2019; Udemba & Agha, 2020; Udemba, Güngör, & Bekun, 2019; Udemba, Magazzino, & Bekun, 2020; Zarsky, 1999).

3 | DATA, AND METHODOLOGY

The present study uses 1974–2018 Turkish annual data. The data includes carbon emissions measured in metric tones per capita, economic growth measured in gross domestic product (GDP) Per capita (constant 2010 US$), energy use measured in kg of oil equivalent per capita, agriculture indexed in agriculture, forestry, and fishing, value added as percent of GDP, and Foreign Direct Investment (FDI), net inflows as percentage of GDP. Turkey was chosen as a case study because of its strategic position as a transition point connect all other countries with Asia and Europe, and this is capable of putting Turkish in a pressure of competing with other developed countries across the globe. Turkey is strategically placed a good market for foreign investors with the attracting factors such as low cost of labour, favourable laws to the foreign investors. Also, with the above average importation of oil and gas as sources of energy consumption in the country, Turkey is likely going to be among the emission induced countries. All the data the authors applied in this investigation are sourced from World Bank Indicator (WDI, 2018), and are all presented in the table below for quick viewing and assessment by the audience (Table 1).

3.1 | Method and model specification

Authors adopted stationarity analyses to ascertained the trends and movement of the variables used in this research, whether they are stationary or not. As it is expected, most time series data have tendencies to expicts some stochastic and trending movements due to some events that could be in form of structural phenomenon, and that are capable of jeopardizing the stationarity of the data.

Also, authors considered QR analyses in this research because of its advantage in giving a robust and accurate estimation of linear regression unlike other approaches. There are many reasons to be rather interested in modelling conditional median (or other quantiles) rather than conditional means, for instance quantiles are more robust to outliers than means and the whole conditional quantile function gives the whole conditional distribution not only its mean. Many

TABLE 1 Summary of the variables

Description of variables	Short terms to the variable	Measurements/Calculations	Sources
Carbon emission	CO_2	metric tones per capita	World Bank Indicator (WDI, 2018)
GDP per capita	GDP	Per capita (constant 2010 US$	World Bank Indicator (WDI, 2018)
Energy use	EU	kg of oil equivalent per capita	World Bank Indicator (WDI, 2018)
Foreign direct investment	FDI	% of GDP	World Bank Indicator (WDI, 2018)
Agriculture, forestry, and fishing, value added	AGRIC	% of GDP	World Bank Indicator (WDI, 2018)

Source: Authors compilation.

applications in economics: wage structure, program evaluation, demand analysis, income inequality, finance, and other areas (ecology, biometrics). In QR, E[g(y)] ≠ g[E(y)], that's why is not possible to use mean. Therefore, the conditional median function $Q_q(y|x)$ is used to consider the relationship between the explanatory and response variable, where the median is quantile q and 0 ≤ q ≤ 1, is that y which divides the data into proportions q below and 1 − q above: $F(y_q) = q$ and $y_q = F^{-1}(q)$: for the median, q = 0.5. If ε_i is the error prediction model, then, in QR, we need to minimizes $\sum_i |\varepsilon_i|$, that is, minimizes the amount of asymmetric penalties $(1-q)|\varepsilon_i|$ for overprediction and $q|\varepsilon_i|$ for underprediction. The QR estimator is assume to be asymptotically normally distributed, however, the QR is categorize as semiparametric, because it avoids assumptions about the parametric distribution of the error process.

We denote $\hat{y}(x)$ as the predictor response variable, then $\varepsilon(x) = y - \hat{y}(x)$ is the prediction of error. The Loss associated with the prediction of errors denote by $L(\varepsilon(x)) = L(y - \hat{y}(x))$, and if $L(\varepsilon) = |\varepsilon|$, the optimal of predictor, denote by $\hat{\beta}$ is equal to the conditional median, which minimizes $\sum_i |y_i - x_i'\beta|$.

The absolute-error loss functions is symmetric, then the sign of the prediction of error in this case is irrelevant. If the quantile q ≠ 0.5, there is a penalty, with the increase in asymmetry as q close to value 0 or 1.

3.2 | Model specification

The objective function of QR estimator for quantile q is

$$Minimizes\, Q_q(\beta) = \sum_{i:y_i \geq x_i'\beta}^{N} q|y_i - x_i'\beta| + \sum_{i:y_i \geq x_i'\beta}^{N} (1-q)|y_i - x_i'\beta|. \quad (1)$$

The linear relationship between the response variable (Environmental performance) and the explanatory variables (GDP, FDI, Agric and Energy) was expressed in general as follow:

$$EP_i = \alpha + X_i'\beta + H_i'U_i. \quad (2)$$

With $P(H_i' > 0) = 1$ where:

EP_i = Environmental Performance, α= intercept, H_i = differentiable transformations of X, X_i = explanatory variables, β = a vector of estimated parameters, U_i = an unobserved random variables with assumption of normal i.i.d. at time i, statistically independent of X_i, and follow the conditions:

$$E(U) = 0 \text{ and } E(1. \quad (3)$$

Therefore, we specify the quantiles function for quantile q as:

$$Q_{EP_i}(qv\varepsilon_i eX_i) = \alpha + \varepsilon_i + \beta_{1q}AGR_i + \beta_{2q}ENR_i + \beta_{3q}FDI_i + \beta_{4q}GDP_i, \quad (4)$$

where:

EP_i = Environmental Performance, AGR = Agriculture, forestry, and fishing, value added (% of GDP), ENR = Energy use (kg of oil equivalent per capita), FDI = Foreign direct investment, net inflows (% of GDP), GDP = GDP per capita (constant 2010 US$), $\varepsilon_i = H_i'U_i$.

4 | EMPIRICAL RESULT AND DISCUSSION

Unit root test was done with the application of the conventional unit root analysis approaches such as Augmented Dickey Fuller (ADF,1979) test and Philip Perron, (PP, 1990) test. Both approaches confirmed mixed order of integration of the variables pointing towards the presence of both stationarity and non-stationarity of the variables. Diagnostic tests like QR was also applied to determine the linear relationship that exist between the selected variables. The results of both QR and the unit root estimate are shown in the Tables 2 and 3 below.

From the Table 3 below, it is observed the display of both the QR and the output of the diagnostic test such as the LM test of serial

TABLE 2 Unit root estimate

Variables	Intercept	@ LEVEL Intercept & trend	Intercept	1st Diff Intercept & trend	Remarks
ADF					
C02	0.0004	−2.9238	−6.5966***	−6.5592***	I(1)
GDP	1.8749	−0.5449	−5.2747***	−5.8518***	I(1)
EU	0.2221	2.5029	−6.3725***	−6.3956***	I(1)
FDI	−1.9057	−3.6200**	−5.5894***	−5.5138***	MIXED
Agric	−3.1050**	−2.0531	−5.5795***	−6.4996***	MIXED
PP					
C02	0.6098	−2.9411	−7.2564***	−8.3525***	I(1)
GDP	2.9554	−0.5592	−5.2726***	−6.0413***	I(1)
EU	0.9553	−2.4557	−6.6757***	−8.6275***	I(1)
FDI	−1.7992	−2.4914	−9.7425***	−9.5566***	I(1)
Agric	−3.5760**	−2.0368	−5.6100***	−6.5020***	MIXED

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%: *p*-value according to (1) Maclean et al. (1996) one-sided *p*-values (2) Kwiatkowski–Phillips–Schmidt–Shin (1992).

correlation and heteroscedasticity. According to the results of the diagnostic estimations, it is discovered that the analysis is free from autocorrelation and heteroscedasticity problems with the insignificant results from both the LM test of serial correlation and heteroscedasticity which reject the null hypothesis of the presence of both autocorrelation and heteroscedasticity. Asides, the confirmation of non-existence of the duo problems of autocorrelation and heteroscedasticity, the authors ascertained the stability and reliability of the analysis with the estimation of cumulative sum (CUSUM) and cumulative sum square ($CUSUM^2$). The outputs of both CUSUM and $CUSUM^2$ with red line bounded by two blue line show that the analysis is sable and reliable. This is shown as the figure that comes after the QR. The QR output as displayed in the table are as follows: A negatively significant relationship between the carbon emission and the agriculture in the all the quantiles except the 90% quantile which shows a positive relationship. Also, the ordinary least square (OLS) estimate which acts as a robust check to the quantile findings confirms a negative relationship between the carbon emission and

TABLE 3 Quantile regression (QR) of CO_2 equation

Quantiles (τ)	α (Constant)	$\beta_{4q}GDP_i$	$\beta_{2q}ENR_i$	$\beta_{3q}FDI_i$	$\beta_{1q}AGR_i$
OLS	24.02123***	2.797395***	1.491694**	−0.39022 ***	−0.000225
0.10 (10th)	20.53879 ***	2.81898 ***	0.12026	−0.25724 *	−0.00069 **
0.20 (20th)	20.16941 ***	2.82204 ***	0.56675	−0.26276 *	−0.00052
0.30 (30th)	19.68145 ***	2.82667 ***	1.25198 *	−0.28362 ***	−0.00025
0.40 (40th)	21.48894 ***	2.81516***	1.41297*	0.33410***	−0.00023
0.50 (50th)	25.15139***	2.79117***	1.53971**	0.42124***	−0.00022
0.60 (60th)	27.24367***	2.77734***	1.22750	0.46806***	−0.00024
0.70 (70th)	26.60045***	2.78279***	1.89158**	0.48092***	−0.00001
0.80 (80th)	28.31231***	2.77163***	2.04331***	−0.52279***	−0.00000
0.90 (90th)	28.27057***	2.77254***	2.41366***	−0.53613***	0.00012

Note: *, **, *** Denotes rejection of the null hypothesis at the 1%, 5% and 10%.
Source: Authors computation.

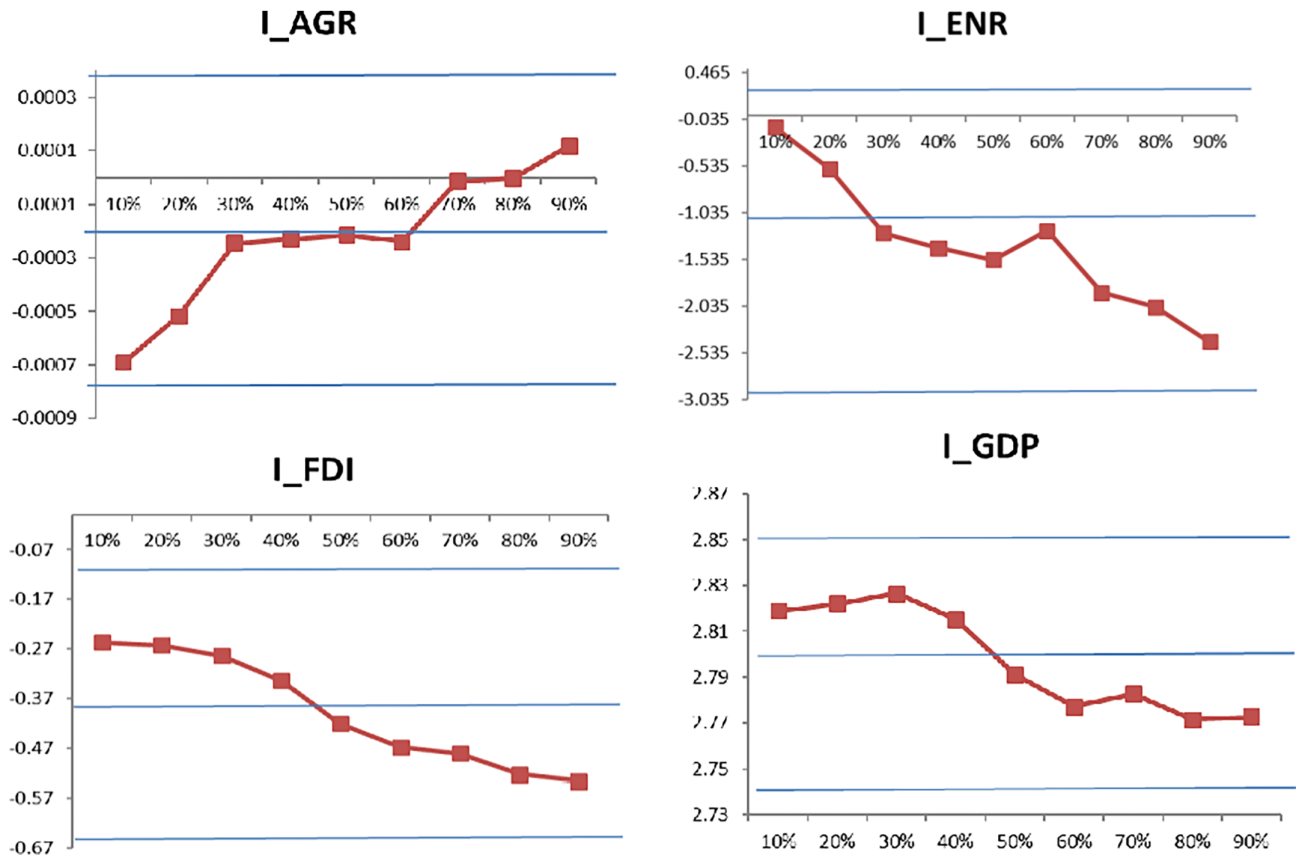

FIGURE 1 Quantiles with the bootstrapped confidence intervals

agriculture. This shows that the increase in agricultural practices in Turkey reduce pollutant emission. This is a good trend for the country, which is a pointer for policy framing around the sector to encouragement positive environmental performance. Quantitatively, it means that a 1% increase in agriculture will lead to a decrease of carbon emission by 0.00069 (−0.00069) and 0.000225 (−0.00023) for 10% quantile and OLS respectively. This finding is support of Dogan (2016) for Turkey; disagree with Elhatip, Afşin, Dirik, Kurmaç, and Kavurmacı (2003) for Turkey. A positively significant relationship is established between energy use and carbon emission in all the quantiles. EU (energy use) is statistically significant for the 30, 40, 50, 70, 80 and 90% quantiles. EU is more statistically significant for the 90% quantile than lower quantiles.

This is not in contrast with the authors expectation as energy use variable used in this work is mostly based on the fossil fuel which is capable of emitting pollution in the environment of Turkey. This is in consonance with the works of Udemba (2019) for China; Udemba et al. (2019) for Indonesia; Udemba et al. (2020) for China; Behera and Dash (2017). Numerically, a 1% point increase in energy use will lead to 0.1203 and 1.4917 increase in carbon emission in Turkey for the 10% quantile and the OLS respectively. Again, a mixed (both positive and negative) relationship is established between foreign direct investment and carbon emission which shows that FDI is impacting the Turkish environment a mixed manner. It shows that the foreign investors still engage in both clean and dirty production in Turkey. This finding gives support to both pollution halo/haven hypothesis (PHH) in Turkey. Numerically, a 1% increase in FDI will lead to 0.007 and −0.39022 increase and decrease in carbon emission in Turkey for 10% quantile and OLS. This finding is in support of the works of Zarsky (1999); Udemba et al. (2019); Udemba et al. (2020); Udemba (2019); Udemba and Agha (2020); Al-mulali and Tang (2013); Alfaro et al. (2010); Bustos (2007). However, a 1% point increase in GDP per capita increases the carbon emission both in all the 10% quantiles and OLS by 2.82 and 2.797% respectively. This shows a positive relationship that exist between GDP per capita and the carbon emission. GDP is statistically significant for all quantiles, and show that there is a strong relationship between CO2 and GDP This is in agreement with the authors' expected relationship between economic growth (GDP) and carbon emission. This supports the findings by Seker et al. (2015); Acaravci and Ozturk (2010) for Turkey.

4.1 | Quantiles with the bootstrapped confidence intervals

The graph above provides a visualization of the difference in coefficients across the quantiles with the bootstrapped confidence intervals. It also includes the OLS estimates, which are constant across all quantiles, and their confidence intervals (Figure 1).

From this graph, we can see that OLS coefficients fall within the confidence intervals of the QR coefficients. This implies that our QR results are not statistically different from the OLS results (Figures 2 and 3).

4.2 | Diagnostic estimates (CUSUM &CUSUM^2)

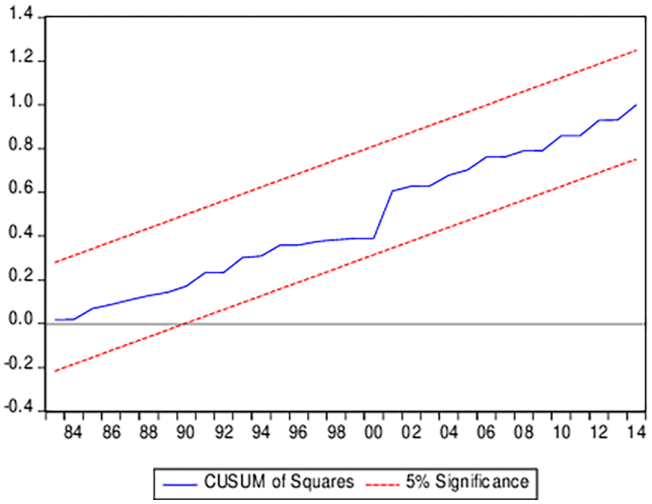

FIGURE 2 Cumulative sum (CUSUM) residual graphical plot

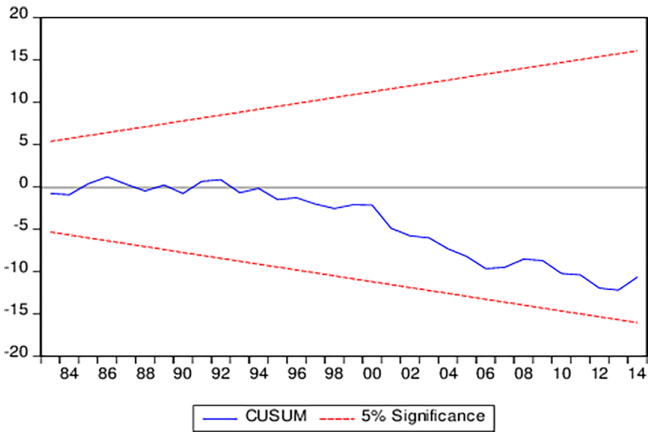

FIGURE 3 CUSUM square residual graphical plot

5 | CONCLUSION AND POLICY

Following the partial involvement of Turkey in curtailing the climate change and its recent policies towards expanding its fossil fuel (Coal) energy source to reduce the over dependence in oil and gas importation, the authors have considered it timely to research on Turkish environmental performance. Considering, how important FDI and agricultural production are to the Turkish economy and the likely emission to generate from these sectors, the authors also consider it important to test the environmental performance with these indexes (FDI and agricultural). The findings from this research will be relevance to other emerging countries that have adopted the growth path through FDI and agriculture. The findings will equally assist in policy framing by the authorities of Turkey to cushion the likely negative effects of FDI and agriculture in pursuit of sustainable development of the country. The findings of this study are as follows: A negatively significant relationship between the carbon emission and the agriculture

in the all the quantiles except the 90% quantile which shows a positive relationship. Also, the OLS estimate which acts as a robust check to the quantile findings confirms a negative relationship between the carbon emission and agriculture. A positively significant relationship is established between energy use and carbon emission in all the quantiles. EU (energy use) is statistically significant for the 30%, 40%, 50%, 70%, 80% and 90% quantiles. EU is more statistically significant for the 90% quantile than lower quantiles. Again, a mixed (both positive and negative) relationship is established between foreign direct investment and carbon emission in all the quantiles which shows that FDI is impacting the Turkish environment a mixed manner. It shows that the foreign investors still engage in both clean and dirty production in Turkey. This finding gives support to both pollution halo/haven hypothesis (PHH) in Turkey. However, a 1% point increase in GDP per capita increases the carbon emission both in the 10% quantiles and OLS by 2.82 and 2.797% respectively. This shows a positive relationship that exist between GDP per capita and the carbon emission. GDP is statistically significant for all quantiles, and show that there is a strong relationship between CO_2 and GDP.

Having ascertained the interactions and relationships that occur amid the designated indexes which expose the stand of Turkey in emission generating and climate change. Hence, the energy use is inducing pollution and the foreign direct investment is causing environmental degradation which leads to the conclusion that pollution haven hypothesis is obtainable in Turkey. The policy implication should consider implementing a sustainable policy that will balance the performance of economy through FDI and environment performance. A conscious effort is expected from the authorities of Turkey in shifting from the excessive use of fossil fuel sources of energy use to a cleaner sources of energy use. Hence, renewable energy sources such as geothermal energy source, hydropower energy source, solar and wind energy sources are highly recommendable for a sustainable development in Turkey.

Conclusively, Turkey should ratify its commitment to the Paris Agreement and work towards achieving the set limit of 1.5°C emission.

CONFLICT OF INTEREST

The authors wish to disclose here that there are no potential conflicts of interest at any level of this study.

ORCID

Edmund Ntom Udemba https://orcid.org/0000-0003-4191-0767

REFERENCES

Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO_2 emissions and economic growth in Europe. *Energy*, *35* (12), 5412–5420.

Acharyya, J. (2009). FDI, growth and the environment: Evidence from India on CO_2 emission during the last two decades. *Journal of Economic Development*, *34*(1), 43–58.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2010). Does foreign direct investment promote growth? Exploring the role of financial markets on linkages. *J Dev Econ*, *91*(2), 242–256.

Al-mulali, U., & Tang, C. F. (2013). Investigating the validity of pollution haven hypothesis in the Gulf Cooperation Council (GCC) countries. *Energy Policy*, *60*, 813–819. https://doi.org/10.1016/j.enpol.2013.05.055

Asgari, M. (2013, January 7). Iran pollution worsens as thousands die. *BBC News*, Middle East. Retrieved from www.bbc.co.uk/news/world-middle-east-11821388

Asumadu-Sarkodie, S., & Owusu, P. A. (2016). The relationship between carbon dioxide and agriculture in Ghana: A comparison of VECM and ARDL model. *Environmental Science and Pollution Research*, *23*, 10968–10982.

Behera, S. R., & Dash, D. P. (2017). The effect of urbanization, energy consumption, and foreign direct. *Renewable and Sustainable Energy Reviews*, *70*, 96–106.

Bustos, P. (2007). Multilateral trade liberalization, exports and technology upgrading: Evidence on the impact of MERCOSUR on Argentinean firms. *mimeo Universitat Pompeu Fabra*,

Carbon Brief. (2018). *The carbon brief profile: Turkey*. Retrieved from Carbonbrief.org: https://www.carbonbrief.org

Cetintas, H., & Sarikaya, M. (2015). CO_2 emissions, energy consumption and economic growth in the USA and the United Kingdom: ARDL approach. *C.Ü. İktisadi ve İdari Bilimler Dergisi*, *16*(2), 173–194.

Dogan, N. (2016). Agriculture and environmental Kuznets curves in the case of Turkey: Evidence from the ARDL and bounds test. *Agricultural Economics*, *62*(12), 566–574.

Elhatip, H., Afşin, M., Dirik, K., Kurmaç, Y., & Kavurmacı, M. (2003). Influences of human activities and agriculture on groundwater quality of Kayseri-Incesu-Dokuzpınar springs, central Anatolian part of Turkey. *Environmental Geology*, *44*(4), 490–494.

Ertugrul, H. M., Cetin, M., Seker, F., & Dogan, E. (2016). The impact of trade openness on global carbon dioxide emissions: Evidence from the top ten emitters among developing countries. *Ecological Indicators*, *67*, 543–555.

Gorg, H., & Stroble, E. (2001). Multinational companies and productivity spilover: A meta analysis. *The Economic Journal*, *11*, F723–F739.

Kohler, M. (2013). CO_2 emissions, energy consumption, income and foreign trade: A South African perspective. *Energy Policy*, *63*, 1042–1050.

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *J. Econ*, *54*(1-3), 159–178.

Lau, L.-S., Choong, C.-K., & Eng, Y.-K. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: Do foreign direct investment and trade matter? *Energy Policy*, *68*, 490–497.

Lee, J. W. (2013). The contribution of foreign direct investment to clean energy use, carbon emissions and economic growth. *Energy Policy*, *55*, 483–489.

Liu, X., Zhang, S., & Bae, J. (2017). The impact of renewable energy and agriculture on carbon dioxide emissions: Investigating the environmental Kuznets curve in four selected ASEAN countries. *Journal of Cleaner Production*, *164*, 1239–1247.

MacLean, D. A., & MacKinnon, W. E. (1996). Accuracy of aerial sketchmapping estimates of spruce budworm defoliation in New Brunswick. *Can J For Res* , *26*(12), 2099–2108.

Pandey, V. C., Singh, K., Singh, J. S., Kumar, A., Singh, B., & Singh, R. P. (2012). *Jatropha curcas*: A potential biofuel plant for sustainable environmental development. *Renewable and Sustainable Energy Reviews*, *16* (5), 2870–2883.

Pao, H.-T., & Tsai, C.-M. (2010). CO_2 emissions, energy consumption and economic growth in BRIC countries. *Energy Policy*, *38*(12), 7850–7860.

Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of the Total Environment*, *646*, 862–871.

Seker, F., Ertugrul, H. M., & Cetin, M. (2015). The impact of foreign direct investment on environmental quality: A bounds testing and causality analysis for Turkey. *Renewable and Sustainable Energy Reviews*, *52*, 347–356.

Shahbaz, M., Dube, D., Ozturk, I., & Jalil, A. (2015). Testing the environmental Kuznets curve hypothesis in Portugal. *International Journal of Energy Economics and Policy*, *5*, 475–481.

Solarin, S., Al-Mulali, U., Musah, I., & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: An empirical investigation. *Energy*, *124*, 706–719.

Udemba, E., & Agha, C. (2020). Abatement of pollutant emissions in Nigeria: A task before multinational corporations. *Environmental Science and Pollution Research*, *27*, 26714–26724. https://doi.org/10.1007/s11356-020-08908-9

Udemba, E., Güngör, H., & Bekun, F. (2019). Environmental implication of offshore economic activities in Indonesia: A dual analyses of cointegration and causality. *Environmental Science and Pollution Research*, *26*(31), 32460–32475.

Udemba, E. N. (2019). Triangular nexus between foreign direct investment, international tourism, and energy consumption in the Chinese economy: Accounting for environmental quality. *Environmental Science and Pollution Research*, *26*, 24819–24830.

Udemba, E. N. (2020a). Mediation of foreign direct investment and agriculture towards ecological footprint: A shift from single perspective to a more inclusive perspective for India. *Environmental Science and Pollution Research*, 1–18.

Udemba, E. N. (2020b). A sustainable study of economic growth and development amidst ecological footprint: New insight from Nigerian Perspective. *Science of the Total Environment*, 139270.*732*,

Udemba, E. N., Magazzino, C., & Bekun, F. V. (2020). Modeling the nexus between pollutant emission, energy consumption, foreign direct investment, and economic growth: New insights from China. *Environmental Science and Pollution Research*, *27*, 17831–17842.

Zarsky, L. (1999). Havens, halos and spaghetti: Untangling the evidence about foreign direct investment and the environment. *Foreign Direct Investment Environment*, *13*(8), 47–74.

Zhang, X.-P., & Cheng, X.-M. (2009). Energy consumption, carbon emissions, and economic growth in China. *Ecological Economics*, *68*, 2706–2712.

AUTHOR BIOGRAPHIES

Edmund Ntom Udemba is an Assistant Professor at the Faculty of Economics Administrative and social science, Istanbul Gelisim University, Istanbul Turkey. He earned a B.Sc. degree in Economics from Enugu state University in Nigeria. He also has both Masters and Doctorate degrees in Economics from Eastern Mediterranean University, Turkey. He has published several research articles in reputable international academic journals. His areas of interest include Macroeconomics, International Trade and Economics, Energy and Environmental Economics.

Anton Abdulbasah Kamil is a Professor of Econometrics at Faculty of Economics, Administrative and Social Sciences, Istanbul Gelisim University, Istanbul, Turkey. He holds Drs in Statistics from the Padjadjaran University, Bandung, Indonesia, M.S. degrees in Applied Statistics from the Bogor Agricultural University at Bogor, Indonesia, and Ph.D in Econometrics from the University of Economics at Prague, Czech Republic (Czechia). Dr. Anton has numerous publications to his credit in journal articles and proceedings. More than hundred articles he published in the journals and proceedings. He continues to be an active researcher in his field. He is also a member of the International Society on Multiple Criteria Decision Making (MCDM). He is on the Editorial Board of the Bulletin of the Malaysian Mathematical Sciences Society (http://www.springer.com/mathematics/journal/40840) and Munich Personal RePEc Archive, Munich University Library (https://mpra.ub.uni-muenchen.de/). Beside that He has been appointed to hold committee positions in several international conferences.

Orhan Özaydın is an Assistant Professor of Department of International Trade and Business, Istanbul Gelisim University, Cihangir neighb. Sehit Jandarma Komando Er Hakan Öner str. No:17 Postal Code:34310 Avcılar, Istanbul, Turkey.

How to cite this article: Udemba EN, Kamil AA, Özaydın O. Environmental performance of Turkey amidst foreign direct investment and agriculture: A time series analysis. *J Public Affairs*. 2022;22:e2441. https://doi.org/10.1002/pa.2441